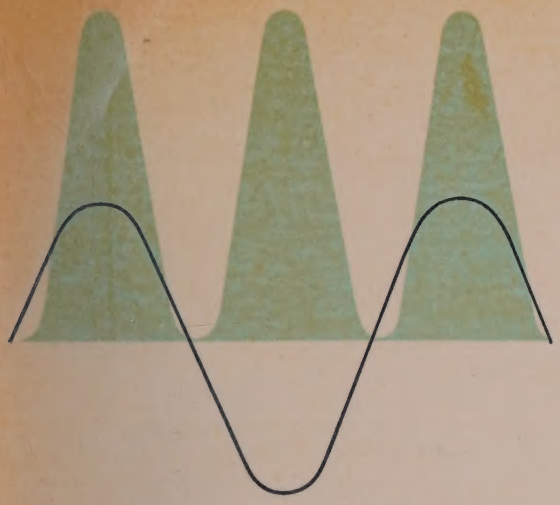


TF 1152A & A/1

25-watt R.F. POWER METERS

OPERATING AND
MAINTENANCE HANDBOOK

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

AMENDMENTS, where applicable, are included at the end of the handbook.

OM 1152A -A/1
Amend. 52120/1
1*- 10/62

HANDBOOK CHANGES

for

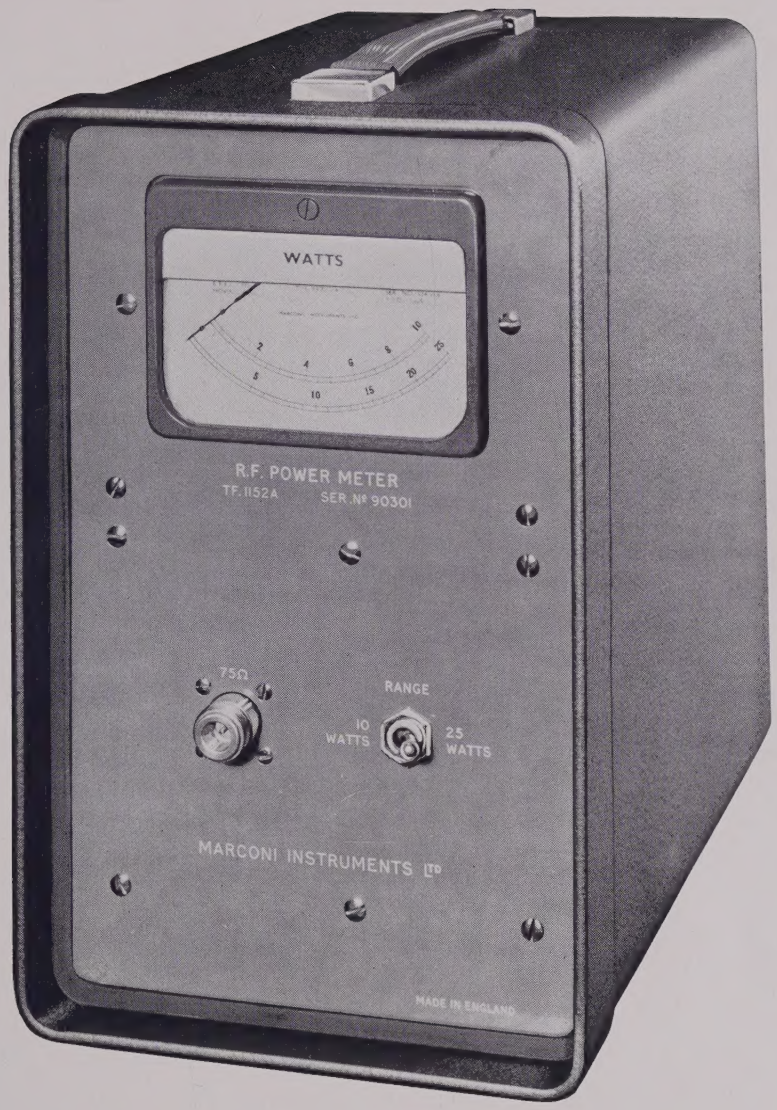
R. F. POWER METER

Types TF 1152A and -A/1

Serial Nos. Prefixed 52120 and above

(1) Sect. 3.2.2. Thermocouple polarity is now indicated by a black dot for the negative lead, and not a red dot for the positive lead.

M.I. Ltd.



OPERATING
AND
MAINTENANCE
HANDBOOK
No. OM 1152A-A/1

R. F. Power Meter

TYPES TF 1152A AND TF 1152A/1

Serial Numbers prefixed JA 862, 52120 and above.

MARCONI INSTRUMENTS LTD., ST. ALBANS, HERTS., ENGLAND

B.W. 4c 9/62/B

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OM 1152A-A/1
1**—9/62

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Schedule of Parts Supplied

The complete equipment comprises the following items:—

1. One R.F. Power Meter Type TF 1152A or TF 1152A/1.

2. One Type N coaxial free plug; 75-ohm for TF 1152A or 50-ohm for TF 1152A/1.

3. One Operating and Maintenance Handbook No. OM 1152A–A/1.

Data Summary

Power Ranges

0·5 to 10 watts and 5 to 25 watts.

Frequency Range

D.C. to 500 Mc/s.

Accuracy of Power Measurement

Within 5% of full scale from d.c. to 250 Mc/s and within 10% of full scale from 250 to 500 Mc/s.

Input Impedance

TF 1152A: 75 ohms.
TF 1152A/1: 50 ohms.

V.S.W.R.

Better than 1·2 from d.c. to 500 Mc/s.

Dimensions and Weight

Height	*Width*	*Depth*	*Weight*
11 in	7 in	12 in	6½ lb
(28cm)	(17 cm)	(31 cm)	(2·8 kg)

1 Description

1.1 GENERAL

The TF 1152A and TF 1152A/1 are direct-reading absorption wattmeters for use at any frequency up to 500 Mc/s. Each has two measurement ranges of 10 and 25 watts full scale. They differ only in input impedance, which is 75 ohms for TF 1152A and 50 ohms for TF 1152A/1.

These instruments measure mean power irrespective of waveform, the power contained in all harmonics up to 500 Mc/s being correctly summed with the power in the fundamental. The meters will therefore indicate the correct increase in power when amplitude modulation is applied to a c.w. input, and thus percentage depth of modulation can be calculated.

Another application is the measurement of the mean power output of pulse transmitters or modulators. The insulation of the input circuit is rated at 500 volts and this allows the application of peak powers of up to 3·3 kW for the 75-ohm version and 5 kW for the 50-ohm version.

Their small size and light weight, and their freedom from internal batteries or external power supplies, make these instruments well suited for mobile use.

1.2 DESIGN DETAILS

The dissipative element in the TF 1152A and TF 1152A/1 consists of a heavy-duty high-stability resistor (R1). This resistor has a tubular ceramic former with a conducting outer coating of cracked carbon, and is mounted so that it forms the central conductor of a slab line of relatively large dimensions.

This load, consisting of the inward-tapering slab line with its resistive central conductor, is of such a configuration that it presents an almost purely resistive input impedance, while, since the outer conductor is in the form of two plates, good air cooling over the whole surface of the resistor is obtained.

The load is matched to the smaller-dimensioned coaxial type N connector by an inward tapering section which preserves a constant impedance between source and load. Thus continuous matching is maintained throughout, giving values of v.s.w.r. close to unity over a wide frequency range.

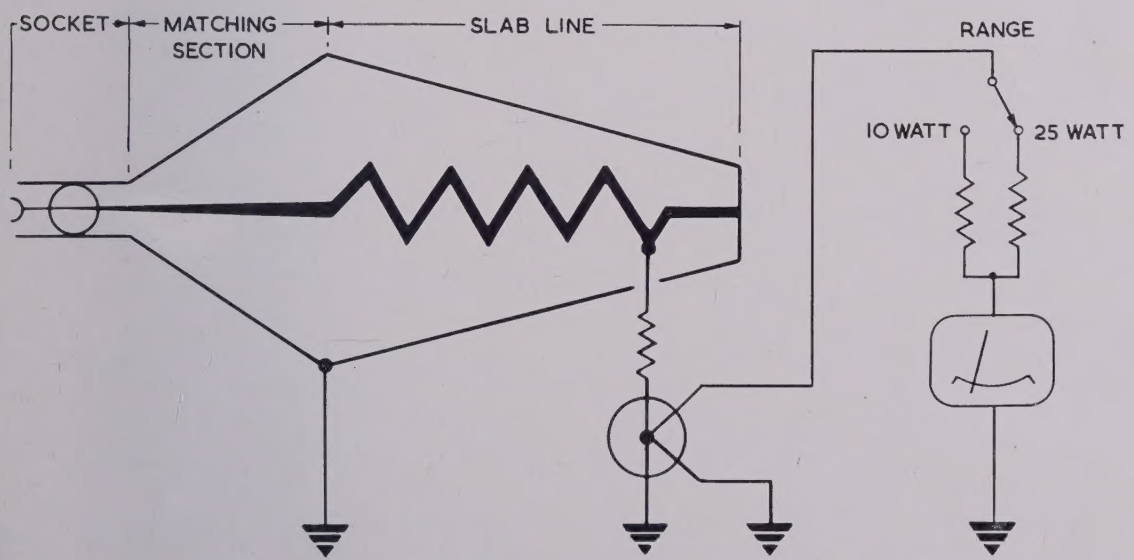


Fig. 1.1 *Functional Diagram*

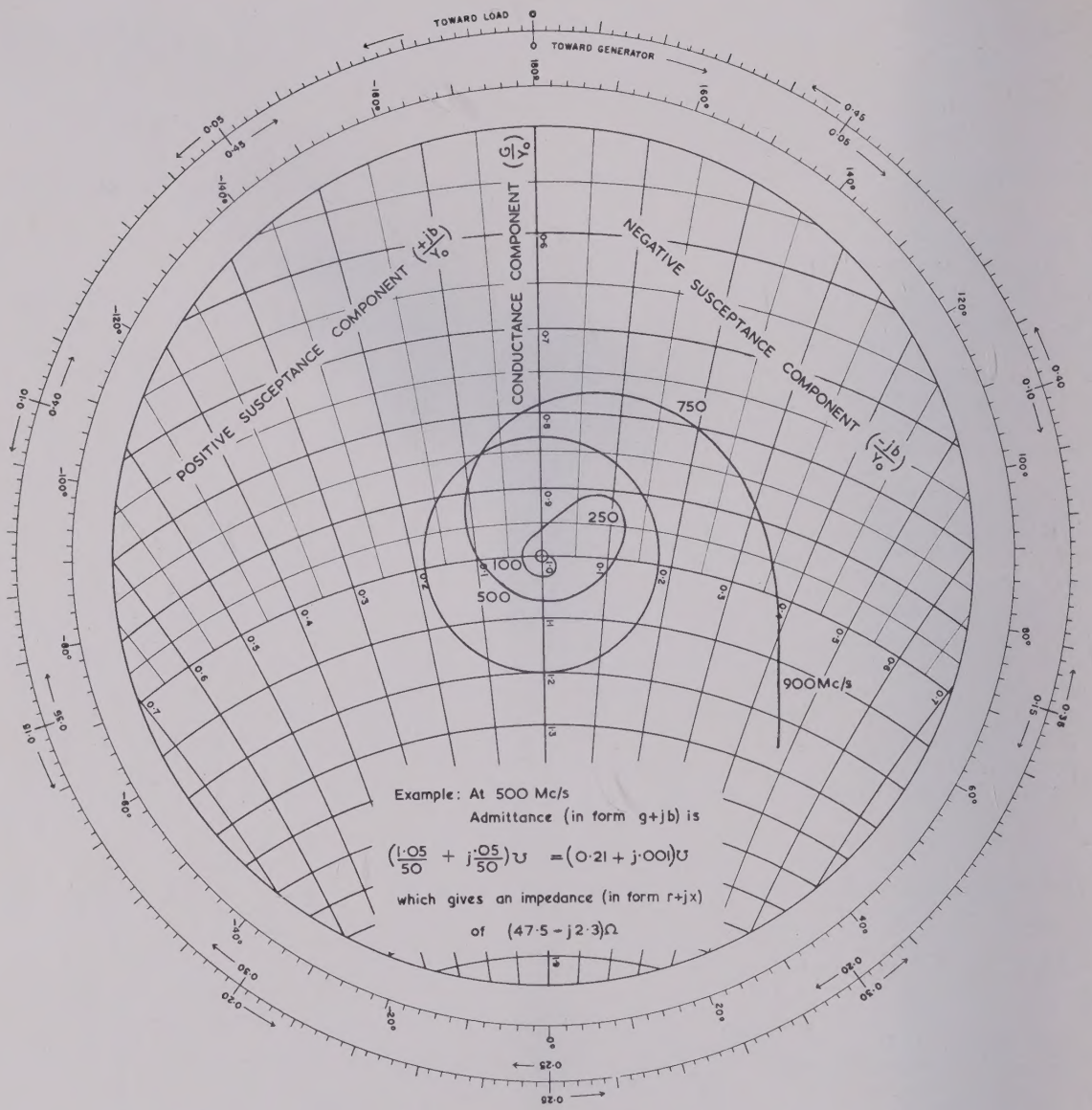


Fig. 1.2 *Admittance Characteristic*

A typical admittance characteristic of a TF 1152A is shown in Fig. 1.2. From this it can be seen that the v.s.w.r. remains better than 1·2 up to 600 Mc/s. Although the measurement accuracy cannot be relied on much above 500 Mc/s, this v.s.w.r. characteristic permits the use of the instrument as a well-matched dummy load at higher frequencies.

Indication of power is by means of a moving coil panel meter (M1) and a robust vacuum thermocouple (X1) whose heater is fed from a tap near the " earthy " end of the main load resistor.

The power range is altered by changing the meter sensitivity, not by varying the proportion of input power applied to the thermocouple; it is thus impossible to damage the thermocouple by inadvertently switching to the wrong power range.

The meter sensitivity is adjusted by two preset series resistors (RV1 and RV2), one for each power range; the appropriate preset resistor is brought into circuit by operation of a toggle switch (SW1) mounted on the front panel.

2 Operation

2.1 GENERAL

There is a constant ratio between power in the main load and power in the heater of the thermocouple feeding the panel meter. Because of this, and because the output from the thermocouple is dependent on the level of power dissipated in its heater, the meter indicates true mean power irrespective of waveform. Thus, power contained in the harmonics of the input is correctly summed with the fundamental; furthermore, since the meter will indicate the correct increase in power when a previously unmodulated input has a.m. applied, modulation depth can be calculated.

2.2 CONNECTIONS

Connection is made to the R.F. Power Meter by means of a type N coaxial socket mounted on the front panel; a suitable type N free plug to mate with this socket is supplied with each instrument. The type numbers of coaxial cables suitable for use with the plugs are as follows:—

TF 1152A (75 ohms)

Great Britain: Joint-Service types UR57 or UR60.
United States: Military Nos. RG-11/U, RG-12/U, or RG-13/U.

TF 1152A/1 (50 ohms)

Great Britain ; Joint-Service type UR 67.
United States : Military Nos. RG-8/U, RG-9/U, or RG-10/U.

2.3 MAKING A MEASUREMENT

Before connecting the instrument to the equipment under test, set the RANGE switch to the position appropriate to the expected power level. If the order of the power level is not known, set the RANGE switch initially to 25 WATTS.

To make a power measurement, connect the source under test to the socket on the front panel of the R.F. Power Meter; the mean power input to the instrument is then read directly on the meter.

When making a measurement, the following points should be borne in mind:—

(1) Ideally, the impedance presented by the Power Meter to a transmitter under test should be purely resistive. In practice, the Power Meter impedance will, inevitably, include a small reactive component (see Fig. 1.2) which will be reflected back into the transmitter tuned-output circuit. This will have the effect of partially detuning the transmitter output stage. In order to obtain a true measure of the power output capabilities of a transmitter, its output stage should always be tuned to produce maximum indication on the Power Meter. This also applies when substituting one power meter for another.

(2) Due to the time lag in thermocouple heating, and also to the low-resistance meter circuit, a slight delay of the order of two or three seconds should be allowed before reading the actual power value.

(3) If the instrument is run at a fairly high power for some time and then a lower power is applied, a suitable period should be allowed for the instrument to attain thermal stability. The time interval will depend on the change in power levels, the degree of accuracy required, and the duration of the high-power measurement; in general, sufficient time should be allowed for the residual reading to fall to zero after each measurement.

(4) The peak voltage that can be applied to the R.F. Power Meter is limited by the input socket insulation; this is rated to withstand a maximum of 500 volts. The peak power that can be applied to the 75-ohm TF 1152A is accordingly of the order of 3·3 kW and, for the 50-ohm TF 1152A/1, 5 kW.

(5) The instrument is calibrated in such a manner that optimum accuracy is obtained when the ambient temperature is 20°C (68°F). The typical temperature/accuracy curve,

Fig. 2.1, may be used to obtain greater accuracy at other ambient temperatures. Protracted power measurements will cause an air temperature increase within the instrument leading to long-term drift. All measurements should, therefore, be made as rapidly as possible. For greatest accuracy, time should be allowed between measurements for the Power Meter to revert to ambient temperature, as discussed in paragraph (3).

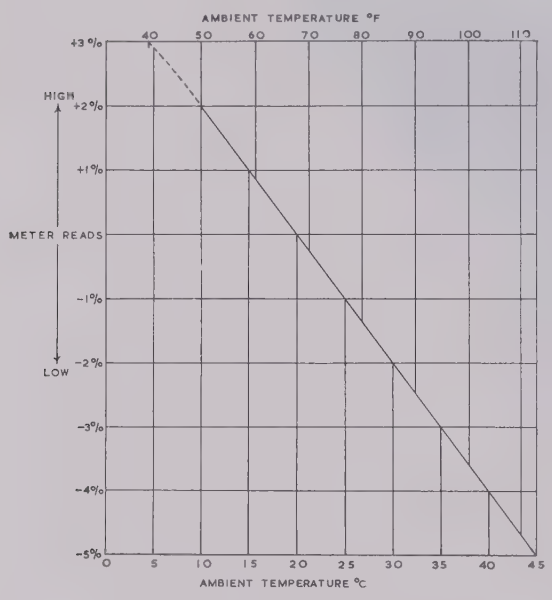


Fig. 2.1 Temperature Correction

2.4 DETERMINATION OF MODULATION DEPTH

The depth of amplitude modulation of an r.f. signal having a sinusoidal envelope can be determined as follows:—

(1) Measure the output power of the source under test with the signal unmodulated. Let this reading be P_C watts.

(2) Modulate the signal and again measure the output power. Let this reading be P_M watts.

(3) Calculate the modulation depth. This can be evaluated since P_C, P_M, and the modulation factor m, are related by

$$P_M = P_C\left(1+\frac{m^2}{2}\right) \quad \ldots\ldots\ldots \quad (1)$$

Transposing and simplifying, equation (1) gives

$$\%\ Modulation = \sqrt{\frac{2(P_M - P_C)}{P_C}} \times 100\% \quad \ldots \quad (2)$$

Example: From measurements, it is found that $P_C = 11$ watts and $P_M = 15$ watts.

Hence, from equation (2),

$$Modulation\ Depth = \sqrt{\frac{2(15-11)}{11}} \times 100\%$$

$$= 85{\cdot}5\%.$$

3 Maintenance

3.1 GENERAL

The Circuit Diagram shows all the electrical components contained in the instrument. The description of these components—their type, value, rating, etc.—is given in the Spares Ordering Schedule; the schedule also lists certain mechanical components.

The physical location of the electrical components is shown in the Component Layout Illustration.

3.2 REMOVAL AND REPLACEMENT OF COMPONENTS

Unless it is absolutely essential and unless the user has the necessary test equipment at his disposal, it is strongly recommended that the component parts of the Power Meter should not be dismantled ***or their positions altered.***

This applies particularly to the inductor L2. This is a compensating inductor included to correct for measurement errors that are liable to occur above about 250 Mc/s because of stray capacitance effects in the thermocouple itself. At lower frequencies, these stray effects can normally be neglected and it is usually only necessary to set the instrument up at a power-supply frequency in order to obtain the necessary accuracy up to about 250 Mc/s.

If accuracy of measurement above about 250 Mc/s is of prime importance, it is recommended that, where practicable, the Power Meter should be returned to Marconi Instruments Service Department for repair and complete recalibration.

3.2.1 REMOVAL OF CASE

To remove the case, lay the instrument panel downwards on the bench and remove the two cheese-headed screws visible on the back panel.

The case can now be lifted away from the front panel to which the internal structure is attached.

3.2.2 THE THERMOCOUPLE (X1)

To detach the thermocouple, first remove L1 and L2 from their respective thermocouple leads; then detach the remaining thermocouple leads from chassis; finally, release the thermocouple from its felt mounting pad.

When fitting a replacement thermocouple, the reverse procedure to that given above should be followed. The base of the thermocouple is secured to its felt mounting pad by means of a rubber cement or similar adhesive.

The heater wires emerge from the glass seal diametrically opposite to each other; the couple leads emerge close together, the positive lead being identified by a red dot on the glass seal. When connecting the components to the thermocouple leads, do not solder the wires closer than about 0·5 cm from the glass seal; also, if it is found necessary to bend the leads, the bend should not be made closer than about 2 mm from the glass seal.

3.2.3 THE LOAD RESISTOR (R1)

The simplest and most satisfactory method of removing the load resistor is as follows:—

(1) Measure the distance between the two side plates of the slab line at the point where screws " P " and " Q " pass through (see Fig. 4.1).
The distance can be expected to be of the order of 1·25 inches on 75-ohm models (TF 1152A) and 1 inch on 50-ohm models (TF 1152A/1). Remove screws " P " and " Q."

(2) Unsolder R2 from the tapping band on R1.

(3) Unsolder, at RV2, the screened lead which interconnects RV2 and C1.

(4) Detach the four chromed screws securing the input socket and the slab line to the front panel.

(5) Remove the two screws which pass through the slab-line assembly between " P " and " Q " and the front panel. The complete assembly can then be removed from the instrument.

(6) Detach the four 6-BA screws securing the front end of the slab plates to the mounting plate surrounding the input socket.

(7) Slacken the two 2-BA screws clamping the " earthy " end of the resistor to the slab plates.

The resistor may now be pulled forwards clear of the slab.

(8) Separate the input socket from the load resistor by applying a soldering iron to the tip of the cone. Care should be taken to make sure that the heat from the soldering iron does not melt the insulating moulding of the socket.

Under no circumstances should the user attempt to separate the resistance element from the cone, as they are permanently bonded together with an epoxy resin. A replacement resistor is supplied complete with cone attached and is tested in accordance with the tests detailed in Section 3.3.2.

To reassemble the slab line and load resistor, reverse the above procedure. It is important that a good soldered connection is made between the cone and the input socket.

3.3 SCHEDULE OF TESTS

The following information, based on abstracts from the internal Factory Test Schedule, is included to enable the user to carry out a series of tests by which the main points of performance of the instrument can be checked; it also gives details concerning adjustment to preset components and the choice of value for individually-selected components.

3.3.1 APPARATUS REQUIRED

(a) Wheatstone Bridge.
(b) Variable D.C. Source; 0 to 30 volts.
(c) D.C. Voltmeter; 0 to 30 volts.
(d) Signal Generator: 100 to 500 Mc/s; Marconi Types TF 801B, C or D (Series) or TF 1066 (Series), 50-ohm output; use in conjunction with 50-ohm to 75-ohm Matching Unit Type TM 4918 for 75-ohm output.
(e) V.S.W.R. Measuring Device, characteristic impedance to suit Power Meter under test; operating range 100 to 500 Mc/s; preferably a slotted-line or standing-wave meter, but an impedance bridge can be used and the v.s.w.r. calculated from measured susceptance and conductance values.
(f) Variable A.C. Source; capable of delivering 25 watts at normal power-supply frequency.
(g) Dynamometer Wattmeter; 0 to 25 watts.
(h) Standardized R.F. Power Meter; Marconi Types TF 1152 (Series).
(i) Stable R.F. Power Oscillator; 100 to 500 Mc/s, variable output, 25 watts or greater.

(h) and (i): See Section 3.3.5.

3.3.2 PRELIMINARY CHECKS

(Apparatus required: Items a, b and c)

The three checks described in this sub-section are carried out on all replacement resistance units before despatch. Therefore, if a replacement unit has been fitted, these checks can be omitted.

When carrying out these checks, it is advisable to set the RANGE switch to 25 WATTS to avoid the possibility of overloading the meter.

(1) Measure the cold d.c. resistance of R1 between the centre conductor of the input socket and chassis. The actual resistance should be within about $\pm 5\%$ of the nominal value.
(2) Apply a voltage of 27·4 volts (TF 1152A) or 22·36 volts (TF 1152A/1) to the input socket. Check that the voltage developed between the tapping band and the "earthy" end of the load resistor is within about 10% of 4 volts.
(3) Measure the linearity of the resistor by means of a d.c. potential-divider method. The simplest way of doing this is to apply a known voltage across the whole resistance and then to measure the voltage developed across (i) a quarter, (ii) a half, and (iii) three-quarters of the resistance length. When making contact to the body of the resistor, do not use a sliding connection as this will tend to scrape the carbon surface off the resistor. The resistance/length characteristic should be linear to within about $\pm 10\%$.

3.3.3 STANDING WAVE RATIO

(Apparatus required: Items d and e)

For the Power Meter to act as a good match to a transmission line, its v.s.w.r. must be as close to unity as possible. In the TF 1152A series of Power Meters, v.s.w.r. is a function of the general configuration and spacing of the slab-line side plates. This spacing can be varied by means of the two screws marked "P" and "Q" in Fig. 4.1. The following paragraphs give the method of adjusting these screws. Normally, this adjustment is best made at 500 Mc/s. Characteristically, the ratio progressively improves with decrease in frequency, but on some models it may be found that a peak in v.s.w.r. is experienced in the region of 300 Mc/s. (See Fig. 1.2.)

Connect the v.s.w.r. measuring device to the Power Meter input socket and set its operating frequency to 500 Mc/s, or as near 500 Mc/s as is convenient. Determine the v.s.w.r. of the Power Meter; it should be less than 1·2. If the v.s.w.r. is greater than this adjust screws "P" and "Q."

The spacing between the slab plates can be increased or decreased as necessary in order to obtain minimum v.s.w.r., but the screw settings should always be kept equal.

Check the v.s.w.r. at a selection of frequencies down to 100 Mc/s. The v.s.w.r. should be less than 1·2 over the whole range.

3.3.4 CALIBRATION ACCURACY AT L.F.

(*Apparatus required: Items f and g*)

The power-reading accuracy is best checked at a low frequency—usually the frequency of the local power supply—and then compared with that of a standardized mean-reading Power Meter near the upper limit of the frequency range. This section deals with the l.f. tests and Section 3.3.5 which follows, describes the r.f. tests.

(1) Connect the dynamometer wattmeter between the a.c. supply and the Power Meter under test. The current and voltage coil connections should be arranged for minimum error due to internal losses, and allowance should be made for the error if it is appreciable.
(2) Set the RANGE switch to 25 WATTS and apply a known power of 20 watts.
(3) Adjust RV1 so that the meter indicates 20 watts.
(4) Reduce the applied power to zero and allow sufficient time for the thermocouple to cool.
(5) Increase the applied power in known increments and check the scale shape of the 25-watt range. It should be such that readings are accurate to within about 2% of full scale; if the accuracy is less than this it will not normally be possible to attain the specified power measurement accuracy of ± 5% of full scale in the high-frequency tests detailed in Section 3.3.5. If the scale shape is not satisfactory at the top end of the scale, it can be corrected by increasing the value of R2; it is important that a replacement R2 should be of a high-stability type. As the correct setting for RV1 is dependent on the value of R2, if R2 is adjusted it will be necessary to readjust RV1 as described in (2) and (3) above. If the value of R2 is increased by too large an amount, then the coverage of RV1 will be insufficient. The value of R2 should then be reduced slightly until a condition is found where both the coverage and scale-shape requirements are met.
(6) Set the RANGE switch to 10 WATTS and apply a known power of 7·5 watts.
(7) Adjust RV2 so that the meter indicates 7·5 watts.
(8) Reduce the applied power to zero and allow sufficient time for the thermocouple to cool.
(9) Increase the applied power in known increments and check the scale shape of the 10-watt range. The actual power indication, at any level, should be within about ± 2% of full-scale deflection.

3.3.5 CALIBRATION ACCURACY AT R.F.

(*Apparatus required: Items h and i*)

After the calibration has been checked at l.f. as described in Section 3.3.4, the Power Meter should, if possible, be compared with a similar Power Meter of established accuracy. The comparison should be carried out at two frequencies, 200 Mc/s and as near 500 Mc/s as is convenient.

200 Mc/s

A stable oscillator should be used as the source of r.f. power. The oscillator coupling must be set to a matching condition, and, if the available oscillator power is sufficient, the output should be fed to the standard instrument via a length of co-axial cable (75-ohm or 50-ohm as appropriate) having a loss of 3 dB, or greater if possible, to assist in obtaining correctness and constancy of source impedance. The oscillator power should be adjusted so that the standard watt meter reads exactly 20 watts on the 25-watt range. The R.F. Power Meter under test can then be substituted for the standard and the oscillator output coupling retuned for maximum deflection on the meter. If the indication differs from that obtained on the standard, the position of the core in L2 should be adjusted until the correct reading is obtained.

500 Mc/s

Having adjusted L2 at 200 Mc/s, increase the oscillator frequency to 500 Mc/s and adjust the oscillator power so that the standard wattmeter reads 20 watts. The R.F. Power Meter under test can then be substituted for the standard and the oscillator output coupling retuned for maximum deflection on the meter. If the indication differs from that obtained on the standard, the position of the adjusting screw "S" should be varied until the correct reading is obtained.

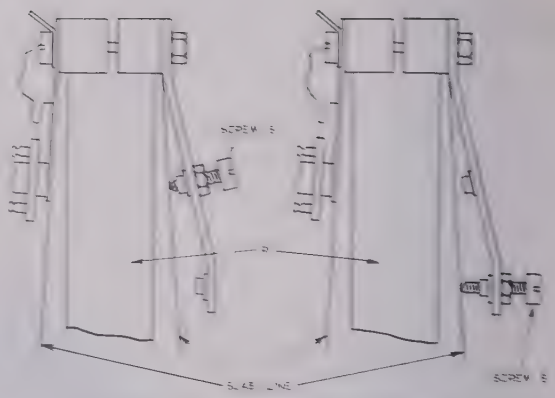
Re-check the calibration accuracy at 200 Mc/s

and, if further adjustment of L2 is necessary, return to 500 Mc s and re-adjust screw "S". Repeat these adjustments alternately, finishing with screw "S", untill correct readings are obtained at both frequencies.

If the final position of screw "S" is very different from its original setting, check the v.s.w.r. as described in Section 3.3.3, and re-adjust screws "P" and "Q" if necessary. In most cases the correct adjustment of screw "S" will serve to *improve* the v.s.w.r.

Having adjusted L2 and screw "S", the Power Meter should be checked at lower frequencies in order to ascertain that the instrument is operating correctly. The accuracy should be within $\pm$ 10% of full scale from 500 to 250 Mc/s and within $\pm$ 5% of full scale below 250 Mc/s.

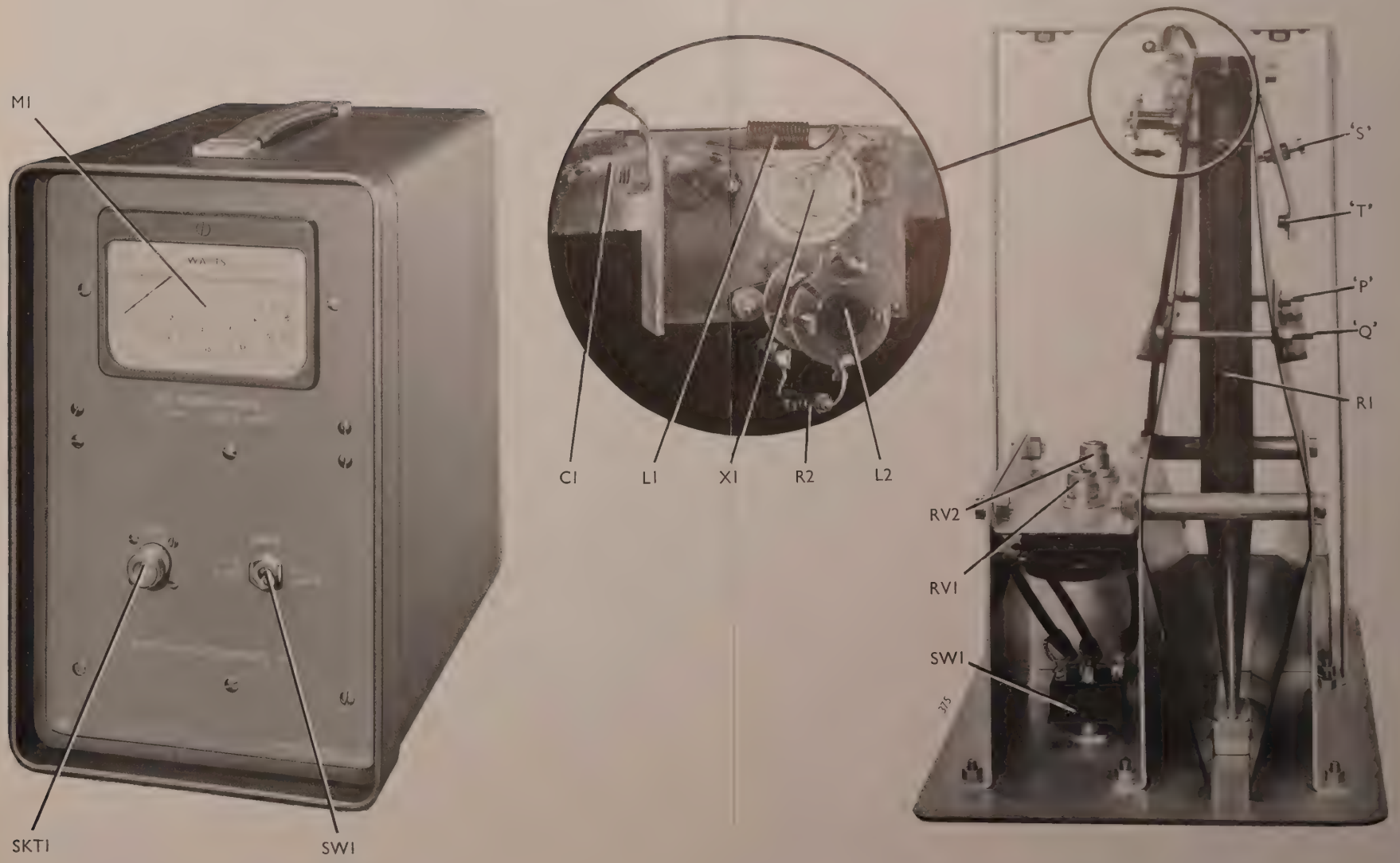
This comparison of the Power Meter under test with the standard should be repeated at a convenient point on the 10-watt range. No adjustment should be made to L2 or screw "S" when checking this range.



TF 1152A (75Ω) TF 1152A/1 (50Ω)

Fig. 3.1 Adjusting screw positions.

Note: On TF 1152A the adjusting screw "S" is in the upper tapped bush, but on the TF 1152A/1 it is in the lower tapped bush "T" as shown in Figs. 3.1 and 4.1.



COMPONENT LAYOUT

5 Spares Ordering Schedule

for R.F. POWER METERS TYPES TF 1152A AND TF 1152A/1

When ordering replacement parts, always quote the TYPE NUMBER and SERIAL NUMBER of the instrument, the QUANTITY required and the appropriate SOS ITEM NUMBER.

For example, to order replacements for the 25-Ω variable resistor, RV1, and the 1000-μμF capacitor, C1, quote as follows:—

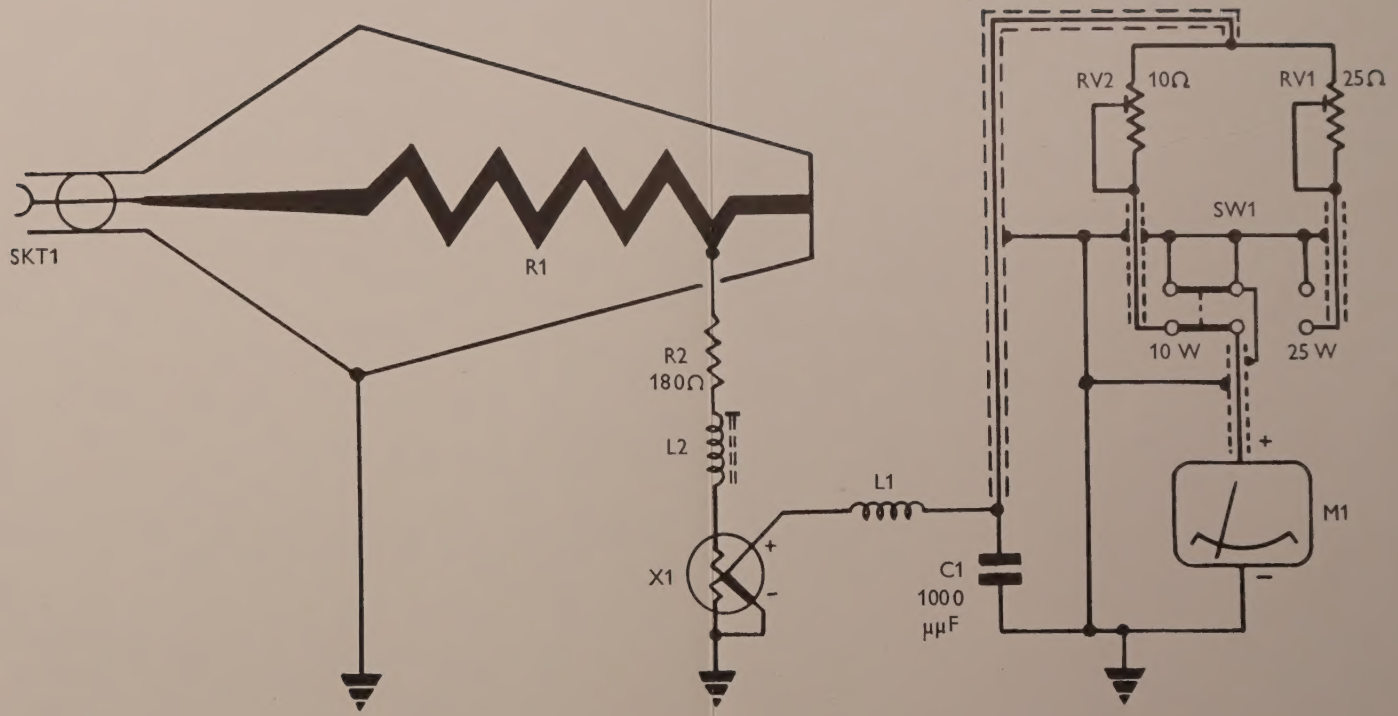
Spares required for TF 1152A (or TF 1152A/1, as appropriate)
Serial No. 000000
1 off, SOS Item 4
1 off, SOS Item 6

It is important that the distinguishing code " SOS " preceding each item number should not be omitted.

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
		ELECTRICAL COMPONENTS	
1	R1	Resistor, Carbon, 75 Ω ± 5%, 30 W, (TF 1152A); complete with bonded input cone and tapping band. This assembly is checked in respect of linearity and position of tapping band before despatch.	TB26878/1 TD25365/1 TE25927/11
2	R1	Resistor, Carbon, 50 Ω ± 5%, 30 W, (TF 1152A/1); complete with bonded input cone and tapping band. This assembly is checked in respect of linearity and position of tapping band before despatch.	TB26878 TD25365/1A TE25927/11
3a	R2	Resistor, High Stability, 220Ω to 240Ω*, ¼W	51-TF1152A
4	RV1	Resistor, Preset, Wire-wound, 25 Ω ± 10%, 1 W.	PC67402/9
5	RV2	Resistor, Preset, Wire-wound, 10 Ω ± 10%, 1 W.	PC67402/5
6	C1	Capacitor, Ceramic, 1000 μμF, 500 V d.c.	53–TF1152A
7	L1	R.F. Inductor.	TB22722/6
8	L2	R.F. Inductor.	TB33334
9a	M1	Meter, Moving Coil, 0–850μA 4·5 Ω ± 1 Ω.	TM3970/64
10	SKT1	Panel Socket, Type N, 75 Ω, (TF 1152A).	40–TF1152A
11		Coaxial Plug to fit Item 10.	41–TF1152A
12	SKT1	Panel Socket, Type N, 50 Ω, (TF 1152A/1).	40–TF1152A/1
13		Coaxial Plug to fit Item 12.	41–TF1152A/1
14	SW1	Switch, Toggle, 2 position, 2 pole.	TB23903/2
15	X1	Thermocouple: heater—25 Ω, 25 mA; couple—4 Ω, 16 to 18 mV.	

* *Nominal Value; actual value determined during calibration.*

SOS Item No.	*Circuit Ref.*	*Description*	*Works Ref.*
		MECHANICAL COMPONENTS	
16		Slab Line Side Plate, Right-hand (TF 1152A): i.e., the plate adjacent to RV1 and RV2.	TD25429/1
17		Slab Line Side Plate, Left-hand (TF 1152A).	TD25429/2
18		Slab Line Side Plate, Right-hand (TF 1152A/1): i.e., the plate adjacent to RV1 and RV2.	TD25364/1
19		Slab Line Side Plate, Left-hand (TF 1152A/1).	TD25364/2
20		Mounting Block; secured to front panel and surrounds SKT1.	TD25365/2
21		U-clamps, Set of Two; secure " earthy " end of R1 to slab line side plates.	TD25365/3
22		Front Panel (TF 1152A).	TD28530
23		Front Panel (TF 1152A/1).	TD28530/1
24		Instrument Case.	TE28529
25		Case Feet, Set of Four.	TA22919
26		Carrying Handle.	TC18996/5
		MISCELLANEOUS	
27		Operating and Maintenance Handbook.	OM1152A–A/1



CIRCUIT DIAGRAM

Fig. 6.1

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